project record

INVESTIGATION OF EQUIPMENT NEEDS FOR CHEMICALLY TREATING HARDWOODS AND CONIFERS

ED&T 2414
CHEMICAL APPLICATOR FOR CONIFER THINNING

FEBRUARY 1976

U.S. Department of Agriculture
Forest Service
Equipment Development Center
Missoula, Montana

NO. 7624 2203

Information contained in this report has been developed for the guidance of employees of the U. S. Department of Agriculture – Forest Service, its contractors, and its cooperating Federal and State agencies. The Department of Agriculture assumes no responsibility for the interpretation or use of this information by other than its own employees.

The use of trade, firm, or corporation names is for the information and convenience of the reader. Such use does not constitute an official evaluation, conclusion, recommendation, endorsement, or approval of any product or service to the exclusion of others which may be suitable.

PROJECT RECORD

INVESTIGATION OF EQUIPMENT NEEDS FOR CHEMICALLY TREATING HARDWOODS AND CONIFERS

ED&T 2414

CHEMICAL APPLICATOR FOR CONIFER THINNING

By

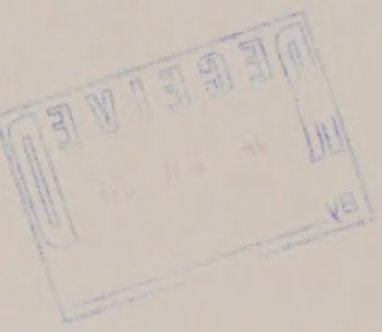
ANTHONY E. JASUMBACK
MECHANICAL ENGINEER

AND

DARRELL BROWN
STAFF TECHNICIAN

February 1976

USDA Forest Service
Equipment Development Center
Missoula, Montana



ABSTRACT

Chemical weeding of hardwoods is often done with tree injectors that weigh from 12 to 20 pounds. The weight of the injector and the dense, bushy stands often encountered make it difficult to find laborers willing to do this arduous work. Chemical weeding of conifers can be potentially dangerous for both the worker and the environment because of the toxic chemicals involved and the methods used to apply them. In response to these problems, the Forest Service Equipment Development Center at Missoula, Mont., investigated ways to improve chemical treatment of hardwoods and conifers. Five methods of chemical hardwood weeding were investigated: all-terrain vehicles, backpack power units, bullets and darts, chain saws, and multiple injectors. At this time, none of these methods is believed to be suitable. Until chemicals are developed that can treat resprouting hardwoods with a single injection, the standard injector will continue to be the lightest, most reliable chemical applicator available.

MEDC personnel investigated the feasibility of developing a dry chemical applicator for conifer thinning to eliminate the splashing and spilling of chemicals during application. Solid or paste forms are feasible, but tests must be conducted to establish which is superior. Manufacturers will then market the superior form and an applicator will have to be developed. To improve conifer thinning in the short run, MEDC developed a pressure-activated valve for use with liquid chemicals to prevent spilling. It is undergoing field tests.

CONTENTS

	Page
ABSTRACT	ii
INTRODUCTION	1
INVESTIGATION OF HARDWOOD TREATMENT	1
Work Guidelines	2
Concepts for Improving Hardwood Chemical Treatment	2
All-terrain Vehicles	2
Backpack Power Units	3
Bullets and Darts	4
Chain Saws	4
Multiple Injectors	5
INVESTIGATION OF CONIFER THINNING	5
Survey of Timber Managers	5
Methods for Chemically Treating Conifers	6
Hypo-Hatchet	6
Hack and Squirt	6
Chemical State	7
DISCUSSION	7
Hardwoods	7
Conifers	8
CONCLUSIONS	8
RECOMMENDATIONS	9

FIGURES

		Page
1.	Commercially available tree injector commonly used in treating hardwoods	1
2.	Hypo-Hatchet	2
3.	Example of a dense stand of timber that would severely limit all-terrain vehicle operation . .	3
4.	Backpack power unit using pressurized gas to obtain naval stores	3
5.	Jet injector used for medical injections	4
6.	Bullet for chemically treating trees	4
7.	Pressure-activated valve	7

INTRODUCTION

In 1972, two proposals for equipment development relating to chemical tree treatment were submitted by Forest Service Units: The Southern Forest Experiment Station, Alexandria, La., asked for engineering assistance to develop a mechanized tree injection system designed around an all-terrain vehicle (ATV), and the Colville National Forest, Pacific Northwest Region (6) (formerly Northern Region (1)), asked for an investigation into the feasibility of a dry chemical applicator for thinning conifers.

The two proposals were included in Equipment Development and Test Project 2414, Mechanized Tree Injector (Chemical Applicator for Conifer Thinning) to improve equipment for treating trees with chemicals. The initial objectives were to investigate the feasibility of a development effort to improve equipment for chemically treating hardwoods and to look into the problem posed by the Colville National Forest. While the investigations were underway, a secondary objective was added: to begin developing an improved chemical applicator for thinning conifers. This report covers the investigations made by Missoula Equipment Development Center (MEDC) personnel, the preliminary development of a chemical applicator for conifers, and the conclusions reached.

INVESTIGATION OF HARDWOOD TREATMENT

MEDC personnel visited the Alexandria Forestry Center, Southern Forest Experiment Station at Alexandria, La., in November 1973. They met with Fred Peevy, a plant ecologist, who submitted the project proposal. For 2 days MEDC personnel visited test plots on pine sites and bottom land hardwood sites. A number of commonly used tree injectors were tried during the visit. A thorough discussion of the problem gave personnel background information.

Commercially available hand-held injectors are the most widely used tools for chemically treating hardwoods. They cut a depression in the base of the tree and fill the depression with a uniform amount of liquid chemical. The operator supplies all the force for the incision. The major problems are the necessity of numerous incisions per tree, the weight of the injector, and the work required to tear the incision.

Simply stated, what is needed is an injector that will make chemical treatment of hardwoods less physically demanding. Present injectors (fig. 1) make a good incision and adequately meter dosages; they are simple, compact, and reliable, but they weigh about 15 pounds empty and are tiring to use all day. A tool is needed that will, in some way, reduce the amount of effort expended by the laborer to inject the tree.

Figure 1.--Commercially available tree injector commonly used in treating hardwoods.

Work Guidelines

Before looking into possible ways to improve chemical treatment equipment these work guidelines were established:

1. Any equipment development work on injectors should be designed around commonly used chemicals, such as 2,4-D amine and Tordon 101. These chemicals do not move laterally from an incision, making multiple incisions necessary. Incision spacing can vary from edge-to-edge to 7 inches, depending on species, season of treatment, and tree diameter.

As new chemicals are developed, it may be possible to kill a tree with one injection. For now, numerous incisions will have to be made around a tree's base for chemical hardwood control.

2. No special effort should be made to put the chemical in another form for hardwood weeding. Liquid chemicals appear to be acceptable for hardwood control.

3. Because many of the hardwood species targeted for control are resprouters, the basal area of stems must be treated. This rules out a short handled tool such as the Hypo-Hatchet (fig. 2), which is used to automatically inject small metered doses of chemical into the tree at breast height.

Figure 2.--Hypo-Hatchet.

4. Treatment sites vary widely and this must be considered in any attempt to improve present tree injectors. Trees to be treated may range from 1 inch to over 12 inches diameter. Stems per acre may vary from less than 100 to more than 1,000. Other factors, such as differing stemwood hardness, presence of brush and limbs around the target area, and the need to treat low on the stem to prevent resprouting, influence applicator design.

Concepts for Improving Hardwood Chemical Treatment

Various equipment concepts to improve the treatment process were discussed in Alexandria and then investigated. They included all-terrain vehicles (ATV's), two types of backpack power units, bullets and darts, chain saws and multiple injectors.

All-terrain Vehicles.--On sites in the South where heavy equipment can operate, mechanical site preparation is becoming the preferred method for eliminating hardwood competition. Dozers or other types of heavy equipment can fell hardwoods and prepare them for disposal in one operation. Chemical treatment, therefore, is best suited to steep slopes, wet conditions or very small areas where heavy equipment would be impractical. As mentioned earlier, a proposal has been made to build a mechanized tree injector around an ATV that can operate under these conditions.

In recent years, ATV's such as the Pug, Cushman Trackster, and certain other vehicles have been developed that perform satisfactorily on both steep slopes (up to 45 percent) and on wet bottom lands. The critical limiting factor for these machines, however, is the presence of obstacles (fig. 3). When downfall is heavy or where brushy conditions prevail, an ATV can quickly become a hinderance to production rather than a help. Even small ATV's like the

Toter and the Rokon Trailbreaker are not able to negotiate the thick, brushy stand conditions often encountered. No ATV has yet proved itself capable of easy cross-country travel through areas of heavy downfall and thick brush.

Figure 3.--Example of a dense stand of timber that would severely limit all-terrian vehicle operation.

To operate powered injectors from an ATV would require hoses from the vehicle to the operator, which would further restrict maneuverability. So it appears that a mechanized injection system built around an ATV could only be used in a fairly open, relatively brush-free, stand of timber.

This type of system has been successful in naval stores operations. Chisel-type cutters powered from an ATV-carried power plant remove sections of bark to induce resin flow. These areas are usually well maintained, however, and are suitable for vehicle use. So the question is, are there enough areas in the South that need hardwood treatment and are suitable for ATV use to justify developing an ATV-supported mechanized injection system?

Backpack Power Units.--Two possible backpack power units, pressurized gas and jet injection (injectors without needles), were investigated. The pressurized gas could be either compressed air or liquid carbon dioxide. The system would consist of a pressure tank on a pack frame, a hose, and an injector (fig. 4). It would provide the force required for the incision, reducing the laborer's workload. Pressure tanks must be sturdily built to meet Department of Transportation or Compressed Gas Association requirements. The tanks are bulky and heavy (empty weight 24 to 33 pounds). Carrying them through the thick brush found on many treatment sites would be tiring.

Figure 4.--Backpack power unit using pressurized gas to obtain naval stores.

The concept of the jet injection system (fig. 5) is to shoot the chemical into the tree with enough force so an incision in the bark is not needed. There must be complete contact between the gun nozzle and the material to be penetrated. If good contact is not achieved, the chemical will not penetrate and will probably splash. Bark porosity and surface texture can hinder sustaining proper contact. The system also has problems of bulk and weight, similar to the pressurized gas system. Instead of a pressure tank, a 25-pound, 110-volt ac electric motor powers the injector. The equipment bulk is nearly the same for both systems and both have hoses that can become tangled. Backpack power units can reduce the work of injecting the chemicals, but the weight and bulk of the equipment make the trade off a poor one for the worker.

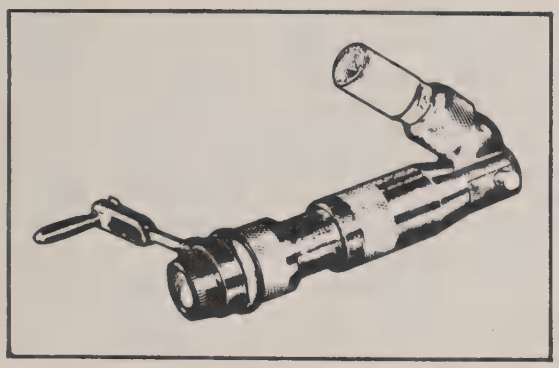


Figure 5.--Jet injector used for medical injections.

Bullets and Darts.--A projectile that is fired into a tree and then leaks chemical into the conductive tissues was investigated. The projectile, either a bullet or a dart, has a hollow chamber that is filled with liquid chemical and a piston at the end of the chamber (fig. 6). When the projectile penetrates the tree, the piston thrusts forward, forcing the chemical out. Leakage or spillage is minimized, but safety problems could occur if the projectiles did not penetrate far enough into the tree. Animals and birds could contact the exposed projectiles and poison themselves. If the projectiles are shot at an angle they could glance off the tree causing serious problems.

Logistically, the use of projectiles would be a problem. The projectile, filled with 1 milliliter of chemical, would weigh about 50 grams. With available chemicals, there must be an average of one projectile for every 2 inches of tree circumference. Since the average diameter of the trees to be treated is about 6 inches, the worker would have to carry approximately 3,600 rounds to treat 400 trees. That many rounds would weigh about 400 pounds. The bulk and weight of the projectiles make this method feasible only if a chemical for one-shot application is developed.

Chain Saws.--In an effort to find equipment to cut a depression and inject the chemical in one operation, MEDC personnel considered mounting a chemical-dispensing attachment on a light chain saw. The operator could cut a notch in the tree and automatically dispense the chemical into the notch. Since one application per tree is not sufficient and allowing for the acceleration and deceleration of the chain saw, this method would be slower than the conventional injectors. Other problems include sites too brushy to allow easy use of chain saws and chemical leakage from the saw chain.

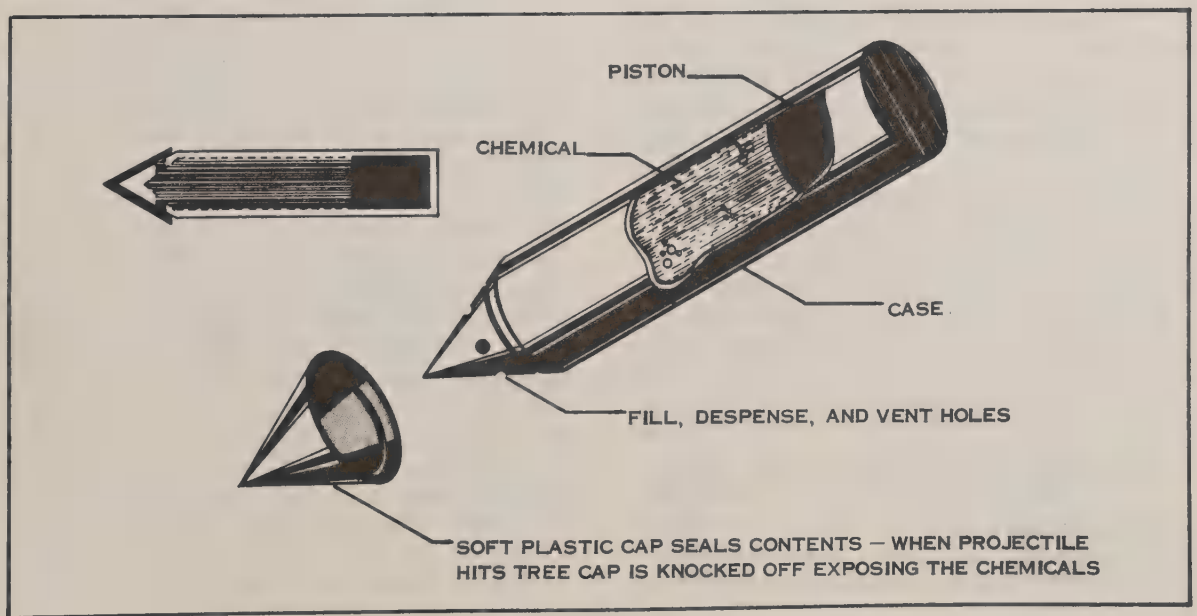


Figure 6.--Bullet for chemically treating trees.

Multiple Injectors.--Multiple injectors would allow the worker to make incisions all the way around the base of the tree without moving. This would decrease the time and effort expended by the worker while thinning large hardwoods on brushy sites. The greatest problem with multiple injectors is the need for a portable power source to make the incisions. A portable power source is questionable at this time, as discussed earlier in this report.

INVESTIGATION OF CONIFER THINNING

In November 1973, MEDC personnel visited timber managers on the Colville National Forest to investigate the problem presented in their project proposal for dry chemical application. Discussions were held primarily with Clifford Lehman, forestry technician on the Colville Ranger District, although other timber management personnel participated. Although the visit was confined to the office, MEDC investigators had previously witnessed chemical thinning operations and were aware of many of the field problems.

Chemical thinning began on the Colville National Forest in 1967. Since that time about 9,000 acres have been treated. An anticipated 4,000 acres will be chemically thinned annually unless new restrictions on chemical use are imposed. Girdling trees with ax cuts was rejected as a potential control method because the tree will often bridge over a narrow notch and cutting a wide notch is too time consuming. The Colville Forest request for engineering help concerned their use of the chemical MSMA, an arsenical now marketed only in liquid form. Using a highly toxic systemic chemical such as MSMA in liquid form presents a health hazard because of splashing and spilling. The Colville Forest uses the hack and squirt technique to apply MSMA, that is, they make the frills with a hand ax (about one frill per 2 inches of diameter) and use a metal oil can to squirt the chemical into the frill. Some Forests reportedly used plastic bottles similar to mustard or ketchup dispensers. The commercially available Hypo-Hatchet was used on the Colville Forest, but was discontinued because splashing occurred when the blade hit the tree.

The Northern Region (1) has established an acceptance limit of three parts per million of the chemical in the body, using urine tests. With trained and experienced crews, the Colville Forest has been able to meet this standard. However, if the chemical thinning program expands, temporary employees or contract workers may be hired, making it perhaps more difficult to maintain high health standards.

To reduce the health hazard posed by handling a toxic liquid chemical under forest work conditions, the Colville Forest investigated the possibility of using MSMA in a solid form. The Key Chemical Co. of Anacortes, Wash., provided the Forest with a sample lot of MSMA in a pill form. Preliminary test results on various species indicate that the solid form is effective.

In discussions with Colville Forest personnel, we found that they are still willing to continue using liquid MSMA, if splashing or spilling could be eliminated. The Hypo-Hatchet would be acceptable if the splash problem could be solved.

The stands being thinned on the Forest vary in density from 500 to 2,000 stems per acre. About 1,200 stems per acre is considered an average; approximately 1/2 gallon of MSMA is used per acre.

Survey of Timber Managers

Timber Management personnel in the Northern (1), California (5), Pacific Northwest (6), Southern (8), and Eastern (9) Regions were contacted to assess their equipment problems

concerning chemically treating trees. This assisted in the evaluation of the need for improved equipment for chemically treating trees, especially conifers.

Region 1 personnel indicated the principal problem is worker safety (splashing of the arsenical). Another serious problem is animals coming into contact with chemical that has dripped to the ground. Region 1 expects to expand its chemical thinning and reports a need for an applicator that dispenses solid or paste chemicals.

Timber Management personnel from Region 5 said the hack and squirt method of applying MSMA is being used to thin about 1,000 acres each year. They are not aware of any safety problems and are encouraging chemical thinning over chain saw thinning. With the proper equipment, they hope to be doing 5,000 to 10,000 acres of chemical thinning a year within 5 years.

The Region 6 response showed a definite need for paste- or solid-form chemicals and an applicator for them. Some 700 to 800 acres a year are currently treated chemically with both Hypo-Hatchet and the hack and squirt method. The Region is aware of the safety problems related to these methods and feels that up to 60,000 acres per year could be treated if these problems are overcome.

Much of the site preparation now done in Region 8 is by machine. Chemical thinning and weeding is restricted to between 8,000 and 12,000 acres a year on sites where mechanical treatment is not feasible. The chemical treatment is done almost exclusively with injectors. Regional timber managers feel chemical treatment will always be needed in the Region, and they recommend a moderate effort to improve tools.

Region 9 has a chemical treatment program of about 20,000 acres a year, divided almost equally between injectors and hatchets (mostly hack and squirt method). The Region has received no complaints concerning either safety or ease of operation. However, if safer, easier, or cheaper chemical treatment methods are found, it would certainly benefit the Region.

Methods for Chemically Treating Conifers

Hypo-Hatchet.--Two primary methods are used to chemically treat conifers: Hypo-Hatchet and hack and squirt. The Hypo-Hatchet is available from TSI Co., Flanders, N.J. Although it is a quick, easy method of treating trees, excess chemical on the blade can splash on impact, posing a safety problem for the worker.

Hack and Squirt.--As mentioned earlier, the hack and squirt method consists of cutting a frill in the tree with a hatchet and squirting the chemical into the frill with an oil can. Human safety problems occur when the chemical dispensers leak or drip, and chemical dripping to the forest floor presents definite environmental problems. If chemical thinning of conifers is to increase, as the regional timber managers MEDC surveyed predict, many of the workers would be temporary unskilled or semiskilled laborers. With a large, inexperienced force, the safety problems would be much more severe. Therefore, an equipment development effort was directed at improving the safety of the hack and squirt method.

An MEDC engineer designed a pressure-activated valve to replace the spout on an oil can (fig. 7). The valve allows the chemical, measured by the oil can pump, to flow into the frill when the activator is pressed against the tree. When the pressure is released, a spring closes the valve preventing leakage or drip. With a reasonable amount of care in placement of the chemical, the dose will stay in the frill until it is translocated into the tree. This valve is currently being evaluated in Region 1.

Chemical State.--One way to minimize the chance of dripping is to apply the chemical in other than liquid form. The chemical MSMA is thixotropic (its viscosity increases over time; under mechanical stress it returns to its original viscosity) and can be formulated in liquid, paste, or solid. These factors increase the possibility that a form can be found that could be easily applied and would readily stay in the tree. In denser forms, there are possible problems with its translocation within the tree. One producer of MSMA will formulate the chemical in any state and viscosity desired and is anxious to develop the necessary applicator as well. Until manufacturers are certain that the form they work on will be accepted, they cannot economically justify beginning development on either the chemical or the applicator.

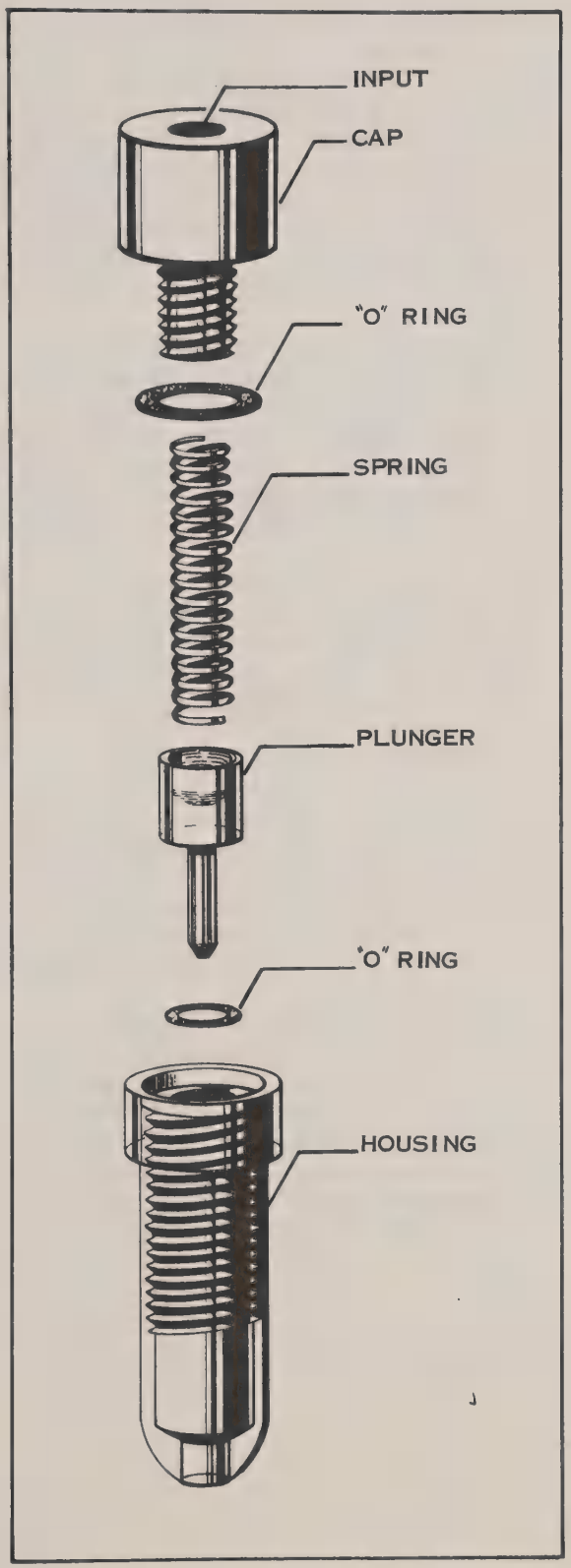


Figure 7.--Pressure-activated valve.

DISCUSSION

Hardwoods

Chemically treating trees with commercially available injectors is hard, heavy work, and finding laborers to perform it is often difficult. The Missoula Center investigated several items of equipment to ease the laborer's workload: ATV's, backpack power units, bullets and darts, chain saws, multiple injectors. None seemed feasible at this time. ATV's are

unsuited for use in dense, brushy stands of timber where chemical treatment is usually needed. Present backpack power units are bulky and offer no advantage in reducing the worker's burden. The bulk and weight of the many projectiles needed to thin with bullets and darts ruled out these methods, and multiple injectors require a portable power source that is not feasible at this time. Chain saws proved too slow.

Conifers

Regional Timber Management personnel from Regions 1 and 6 agreed with the Colville Forest's belief that methods now in use for chemically treating conifers are potentially dangerous. If the safety problems incurred with the hack and squirt method or the Hypo-Hatchet were eliminated, the methods would be quite satisfactory. A special valve, developed for use on oil cans in the hack and squirt method, is being evaluated in Region 1.

Chemical companies report that it is feasible to produce MSMA in any viscosity or density, from a thin liquid to a pellet. When tests show which is better, the paste or the solid, the companies will develop the chemical in the superior state. Until then, they see no way to justify development.

CONCLUSIONS

1. Commercially available injectors for treating hardwoods are heavy, and using them in the frequently encountered, dense, brushy stands is hard work. However, no mechanized method appears to be feasible at this time to ease the laborer's burden, and until a chemical that will kill hardwoods and prevent resprouting with one application is developed, it is doubtful that a simpler, lighter, more compact, or more reliable injector will be developed.

2. Current methods for chemically treating conifers may be harmful, both to the laborer and to the environment. These methods effectively treat conifers and would be quite satisfactory if the safety problems could be eliminated.

3. The demand for chemical treatment of conifers and the potential increase in its use if safety is improved indicates a need for a continued equipment development effort.

4. Use of systemic chemicals such as MSMA to thin conifers is certain to increase in the future. If the methods of applying them were improved to more adequately protect the worker and the environment, use of chemicals would accelerate substantially.

5. Using the chemical in a solid or paste form might reduce potential hazards. At least one producer of MSMA is willing to explore using the chemical in a different form. Until it is determined if paste or solid is better than the liquid, however, justifying development in these areas will be difficult.

RECOMMENDATIONS

1. Unless it can be shown that there are sufficient areas in the South where hardwood control can be accomplished with a vehicle-borne mechanized tree injector system, no effort should be made to improve the commercially available tree injectors, until a single application chemical is developed.

2. The Center should continue to work with the Colville National Forest to develop a pressure-activated valve to reduce the hazard of using liquid MSMA.

3. The Center should continue evaluating paste and solid forms of MSMA for conifer thinning.